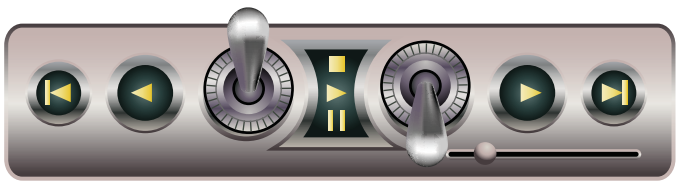
Flight Surgeon Refresher Course

Section 4: Aviation Safety

DoD Human Factors Classification System (HFACS) (FSRC405)



AVIATION SAFETY

Introduction

This lesson will instruct you on the DoD Human Factors Classification System (HFACS), which has been directed for implementation into the individual service Aviation Safety programs. The material presented here is extracted directly from the DoD Human Factors Guide.

This system is based on James Reason's very familiar "Swiss Cheese" model for human error in the production of accidents. An understanding of this system is not only required in accident investigations, but will also enable your deductive instigative capabilities.

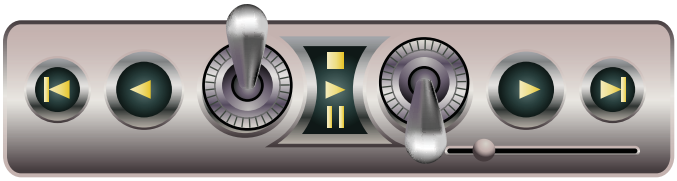
Objectives:

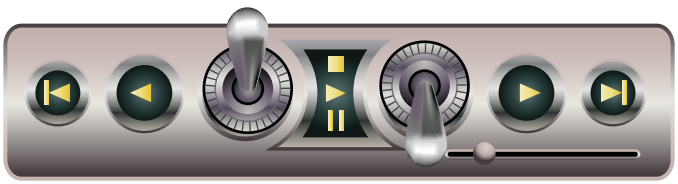
a. Describe the DoD Human Factors Classification System (HFACS).

b. Discuss the principles of latent failure and the "Swiss Cheese" model for human error.

c. Discuss the history of the development of the DoD HFACS.

d. Classify human factors each of the four main tiers of the DoD HFACS including Acts, Preconditions, Supervision, Organizational Influences.





Executive Summary

This Department of Defense Human Factors (DoD HF) Guide explains procedures for investigating and reporting all DoD mishaps. It supports DoDI 6055.7, Accident Investigation, Reporting, and Record Keeping. The DODI directs DoD components to "Establish procedures to provide for the cross-feed of human error data using a common human error categorization system that involves human factors taxonomy accepted among the DoD Components and U.S. Coast Guard." It is intended for use by all persons who investigate, report and analyze DoD mishaps, and is particularly tailored to the needs of persons assigned to Interim Safety Boards and formal Safety Investigation Boards following all Classes of mishaps. There are myriad potential human factors, all of which need to be assessed for relevancy during a mishap investigation. No investigator, flight surgeon, physiologist, human factors consultant or aviation psychologist can be expected to be fully familiar with all potential human factors.

When using this human factors model, the investigator should consider applying the model to three distinct areas of consideration: environmental, individual and the event or mishap. The mishap crew, operator, or team reacts to the environment to which they are exposed. The environmental factors cover not only the physical environment to which the individual members are exposed, but also the organizational and supervisory environments and specific physical and technological preconditions. The individual factors cover acts, precondition and supervision factors. The mishap factors can cross all four tiers of the model. The investigator can apply this model by entering at any tier that is specifically related to environmental, individual or mishap factors discovered during the analysis. This model can be used as either a primary or secondary tool to investigate both active and latent failures. Our model is designed to present a systematic, multidimensional approach to error analysis. This human factors model covers human error from three perspectives:

- Cognitive Viewpoint and Human System Interaction and Integration
- Human-to-Human Interaction
- Sociocultura**l and Organization**

When using our DoD HF Taxonomy for either primary investigation or secondary analysis, we must assume error can mean several things:

- Error as the failure itself. For example: The operator's decision was an error (decision, perceptual, or skill-based errors).
- Error as the cause of failure. For example: This event was due to human error (failure to provide guidance).
- Error as a process or, more specifically, as a departure from some kind of standard (exceptional, routine, intentional or unintentional).

A reasonable synthesis of these assumptions, as suggested by Senders and Moray (1991), is the following: Human error occurs when human action is performed that was either (1) not intended by the actor, (2) not desired according to some specified set of rules or by some external observer, or (3) contributed to the task or system "going outside its acceptable limits."

This DoD Guide starts with a brief history of the development of the DoD HFACS, followed by an introduction and description of the human factor and human performance application of this model. The Guide concludes with a high-level structural overview of the taxonomy and definitions.

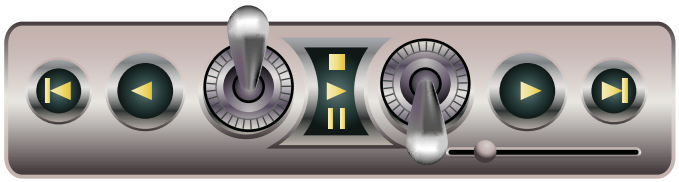
History

The Secretary of Defense published a memorandum 19 May 2003 stating, "World-class organizations do not tolerate preventable accidents. Our accident rates have increased recently, and we need to turn this situation around. I challenge all of you to reduce the number of mishaps and accident rates by at least 50% in the next two years. These goals are achievable, and will directly increase our operational readiness. We owe no less to the men and women who defend our Nation."

DoD Safety Oversight Committee

This memorandum resulted in the creation of the DoD Safety Oversight Committee to provide guidance to the DoD and individual services on best practices and methods to accomplish this mandate. The Secretary of Defense established the Defense Safety Oversight Council to:

- Review accident and incident trends, ongoing safety initiatives, private sector and other governmental agency best practices, and to make



recommendations to the Secretary of Defense for safety improvement policies, programs, and investments.

- Assess, review and advise on improving all aspects of the coordination, relevance, efficiency, efficacy, timeliness and viability of existing DoD-wide safety and injury prevention information management systems.
- Promote the development and implementation of safety initiatives, including Systems Safety for Acquisitions and operations, to improve mission success as well as preserve human and physical resources throughout DoD.
- Coordinate with other federal agencies and industry leaders, to facilitate communication, coordination, and integration of best practices into DoD planning, development and implementation of initiatives and programs that support research to improve human performance, safety education standards/procedures, and equipment.

Aviation Safety Improvement Task Force (ASI-TF)

The Aviation Safety Improvement Task Force (ASI-TF) was established to meet these DoD requirements. The ASI-TF subsequently established the Human Factors Working Group with a charter to identify data-driven, benefit focused, human-factor and human-performance safety strategies designed to identify hazards, mitigate risk and reduce aviation mishaps inherent in aircraft operations throughout DoD. The ASI-TF chair directed the HFWG to accomplish the following tasks:

- Promote common Human Factors Analysis and Classification System for DoD-wide implementation
- Recommend standardization of human factor and human performance terminology
- Provide human factors subject matter experts to all ASI-TF working groups, and hazard identification and intervention analysis teams
- Identify and analyze top human factor and human performance mishap focus areas
- Identify, catalog and recommend approaches to improve organizational/cultural assessments

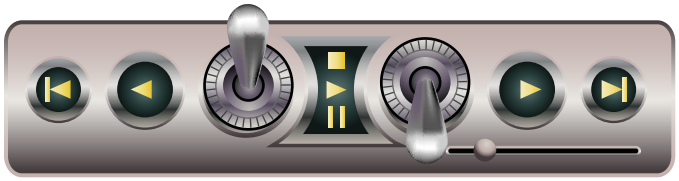
This guide is produced to meet the first two tasks of the Human Factors Working Group. The guide was initially developed to investigate aviation mishaps, and therefore uses an aviation-centric language. During production the authors have attempted to modify definitions to ensure the tool can be used in the investigation of multiple types of events. This guide was developed based on the evolution of the works produced by Jens Rasmussen, James Reason as well as Douglas Wiegmann and Scott Shappell. As this dynamic document evolves, we plan to ensure that it can be seamlessly applied across all services, and will be used to investigate aviation, ground, weapons, afloat, space and off-duty mishaps and events.

Introduction

Mishap or event investigation can be extremely difficult, time-consuming and stressful, but it can also be rewarding when we recognize that the contributions we make will improve safety. A thorough mishap investigation is absolutely necessary to determine the cascading events causal to a mishap, and to recommend corrective actions to prevent recurrence. This guide provides the accident investigator with a proven template that aids in organizing the investigation while providing a detailed analysis of human error for on-scene investigation and post-hoc mishap data analysis, revealing previously unidentified human-error trends and hazards.

Human error continues to plague both military and civilian mishaps. Analysis indicates that human error is identified as a causal factor in 80 to 90 percent of mishaps, and is present but not causal in another 50 to 60 percent of all mishaps, and is therefore the single greatest mishap hazard. Yet, simply writing off mishaps to “operator error” is a simplistic, if not naïve, approach to mishap causation and hazard identification. Further, it is well established that mishaps are rarely attributed to a single cause, or in most instances, even a single individual. Rather, mishaps are the end result of myriad latent failures or conditions that precede active failures (Shappell in “The Naval Flight Surgeon’s Pocket Reference to Aircraft Mishap Investigation”). The goal of a mishap or event investigation is to identify these failures and conditions in order to understand why the mishap occurred and how it might be prevented from happening again.

This reference is an adjunct to formal instructions that govern mishap investigation and is not meant to sup-



plant the other references that address service-specific guidance for mishap investigation. Use this guide as a ready reference in the field to ensure that your data retrieval is complete and that you preserve perishable evidence. This guide is also designed to ensure uniformity of inter-service human factors definitions and data driven analysis.

Description

This guide is designed for use as a comprehensive event/mishap, human error investigation, data identification, analysis and classification tool. It is designed for use by all members of an investigation board in order to accurately capture and recreate the complex layers of human error in context with the individual, environment, team and mishap or event.

In the past, investigators have thrown human factors analysis to the medical investigator and have asked him or her to do this work on their own. This practice has sometimes produced human error analyses that differed considerably from the boards' investigation and findings of fact. Integrating human factors analysis into all aspects of the investigation will result in a much more coherent final product.

As described by Reason (1990), active failures are the actions or inactions of operators that are believed to cause the mishap. Traditionally referred to as "error", they are the last "acts" committed by individuals, often with immediate and tragic consequences. For example, an aviator forgetting to lower the landing gear before touch down or showing off through a box canyon will yield relatively immediate, and potentially grave, consequences.

In contrast, latent failures or conditions are errors that exist within the organization or elsewhere in the supervisory chain of command that effect the tragic sequence of events characteristic of a mishap. For example, it is not difficult to understand how tasking crews or teams at the expense of quality crew rest can lead to fatigue and ultimately errors (active failures) in the cockpit. Viewed from this perspective then, the actions of individuals are the end result of a chain of factors originating in other parts (often the upper echelons) of the organization. The problem is that these latent failures or conditions may lie dormant or undetected for some period of time prior to their manifestation as a mishap.

The question for mishap investigators and analysts alike is how to identify and mitigate these active and latent failures or conditions. One approach is the "Domino Theory" which promotes the idea that, like dominoes stacked in sequence, mishaps are the end result of a series of errors made throughout the chain of command.

A "modernized" version of the domino theory is Reason's "Swiss Cheese" model that describes the levels at which active failures and latent failures/conditions may occur within complex operations (see Figure 1).

Working backward from the mishap, the first level of Reason's model depicts those Unsafe Acts of Operators (operator, maintainers, facility personnel, etc.) that lead to a mishap. Traditionally, this is where most mishap investigations have focused their examination of human error, and consequently where most causal factors are uncovered. After all, it is typically the actions or inactions of individuals that can be directly linked to the mishap. Still, to stop the investigation here only uncovers part of the story.

What makes Reason's model particularly useful in mishap investigation is that it forces investigators to address latent failures and conditions within the causal sequence of events. For instance, latent failures or conditions such as fatigue, complacency, illness, and the physical/technological environment all affect performance but can be overlooked by investigators with even the best of intentions. These particular latent failures and conditions are described within the context of Reason's model as Preconditions for Unsafe Acts. Likewise, Supervision can promote unsafe conditions

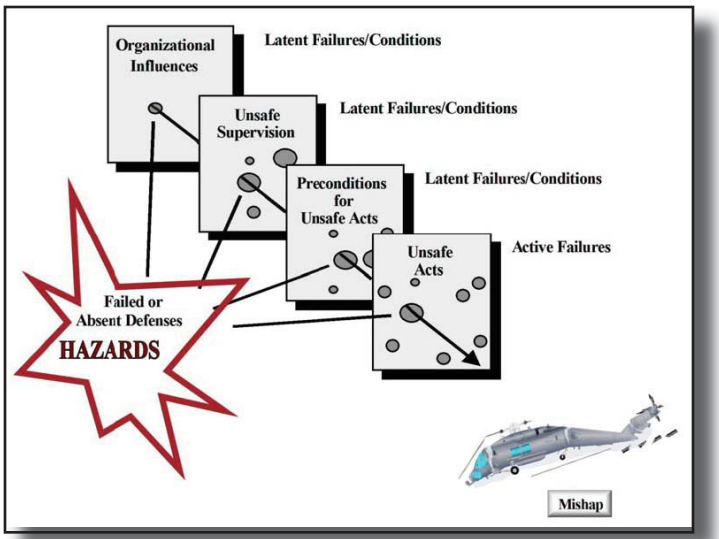


Figure 1. The "Swiss Cheese" Model (adapted from Reason, 1990)

of operators and ultimately unsafe acts will occur. For example, if an Operations Officer were to pair a below average team leader with a very junior/inexperienced crew, the result is increased risk of mission failure. Regardless, whenever a mishap does occur, the crew naturally bears a part of the responsibility and accountability. However, latent failures or conditions at the supervisory level are often equally responsible for poor hazard analysis and subsequent increased mission risk, and may ultimately cause the mishap. In this particular example, the crew was set up for the opportunity for failure.

Reason's model does not stop at supervision; it also considers Organizational Influences that can impact performance at all levels. For instance, in times of fiscal constraints, funding may be short and may lead to limited training opportunities. Supervisors are sometimes pressed to task "non-proficient" crews with complex missions.

Not surprisingly, unintended and unrecognized errors may appear, and mission performance will consequently suffer. As such, hazards and risks at all levels must be addressed if any mishap investigation process is going to be effective.

The investigation process then endeavors to detect and identify the "holes (hazards) in the cheese" (see Figure 1).

So how do we identify these hazards? Aren't they really too numerous to define? After all, every mishap is unique, so the hazards will always be different for each mishap ... right? Well, it turns out that each mishap is not unique from its predecessors. In fact, most mishaps have very similar causes. They are due to the same holes in the cheese, so to speak. The hazards identified in each new mishap are not unique to that mishap. Therefore, if you know what these system failures/hazards or "holes" are, you can better identify their roles in mishaps -- or better yet, detect their presence and develop a risk mitigation strategy correcting them before a mishap occurs.

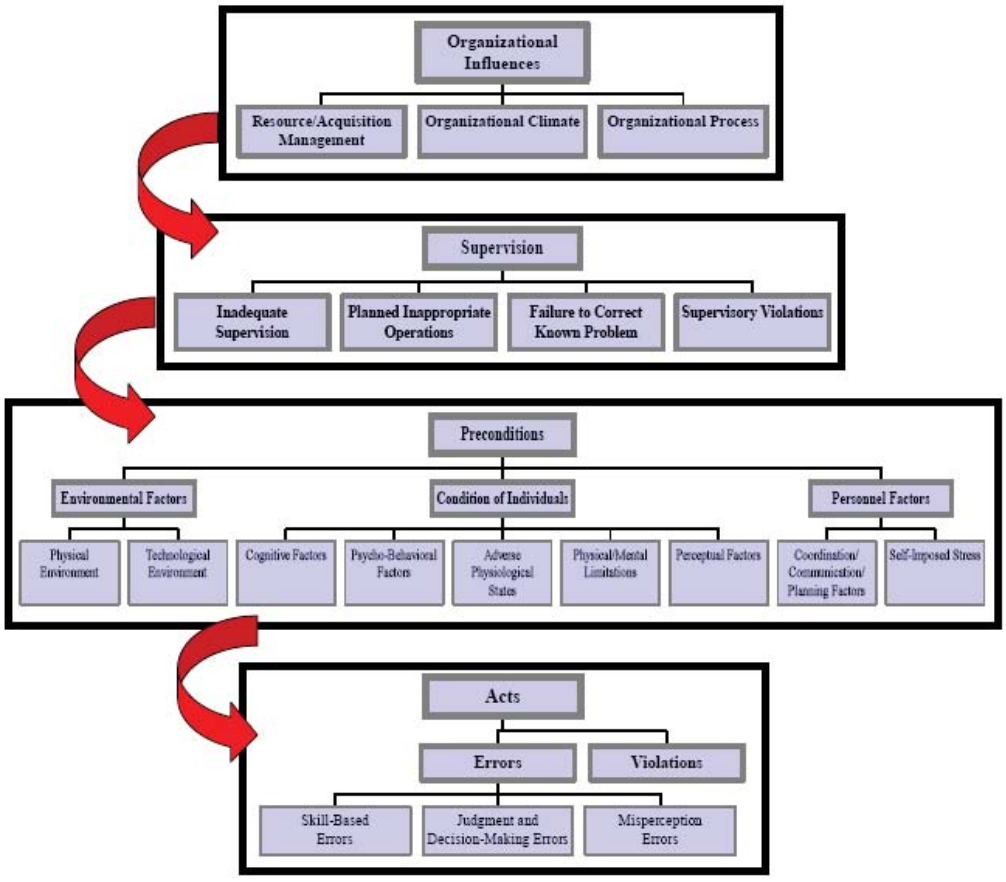


Figure 2. DoD HFACS Model

Department of Defense (DoD) Human Factors Analysis and Classification System

Drawing upon Reason's (1990) and Wiegmann and Shappell's (2003) concept of active failures and latent failures/conditions, a new DoD taxonomy was developed to identify hazards and risks called the DoD Human Factors Analysis and Classification System. DOD-HFACS describes four main tiers of failures/conditions:

1. **Acts**
2. **Preconditions**
3. **Supervision**
4. **Organizational Influences**

A brief description of the major tiers with associated categories and sub-categories follows, beginning with the tier most closely tied to the mishap.

Attachment 1 is not included in this lesson, but is available in the DoD HF Guide. It is the in-depth reference document, and contains all the currently accepted definitions for the sub codes that fall within the 4 major tiers of human error.

1. Acts

Acts are those factors that are most closely tied to the mishap, and can be described as active failures or actions committed by the operator that result in human error or unsafe situation. We have identified these active failures or actions as Errors and Violations (see Figure 3).

Errors: Errors are factors in a mishap when mental or physical activities of the operator fail to achieve their intended outcome as a result of skill-based, perceptual, or judgment and decision making errors, leading to an unsafe situation. Errors are unintended. We classified Errors into three types: Skill-Based, Judgment and Decision Making, and Misperception Errors. Using this error analysis process, the investigator must first determine if an individual or team committed an active failure. If so, the investigator must then decide if an error or violation occurred. Once this is done, the investigator can further define the error.

Skill-based Errors: Skill based errors are factors in a mishap when errors occur in the operator's execution of a routine, highly practiced task relating to procedure, training or proficiency and result in an unsafe a situation. Skill-based Errors are unintended behaviors.

Judgment and Decision Making Errors: Judgment and Decision making errors are factors in a mishap when behavior or actions of the individual proceed as intended yet the chosen plan proves inadequate to achieve the desired end-state and results in an unsafe situation.

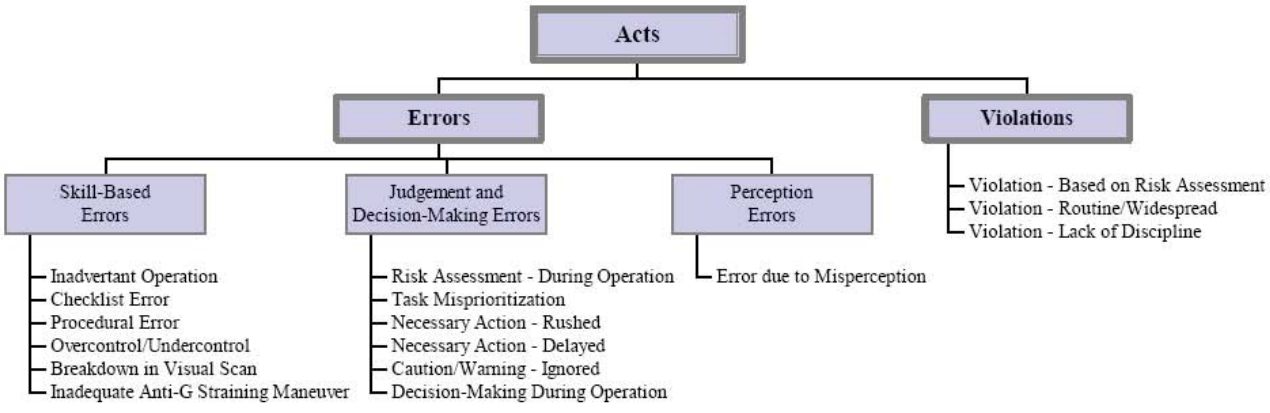
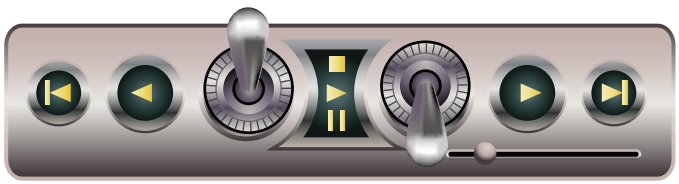


Figure 3. Categories of Acts of Operators



Misperception Errors: Misperception errors are factors in a mishap when misperception of an object, threat or situation (such as visual, auditory, proprioceptive, or vestibular illusions, cognitive or attention failures) results in human error .

Violations: Violations are factors in a mishap when the actions of the operator represent willful disregard for rules and instructions and lead to an unsafe situation. Unlike errors, violations are deliberate.

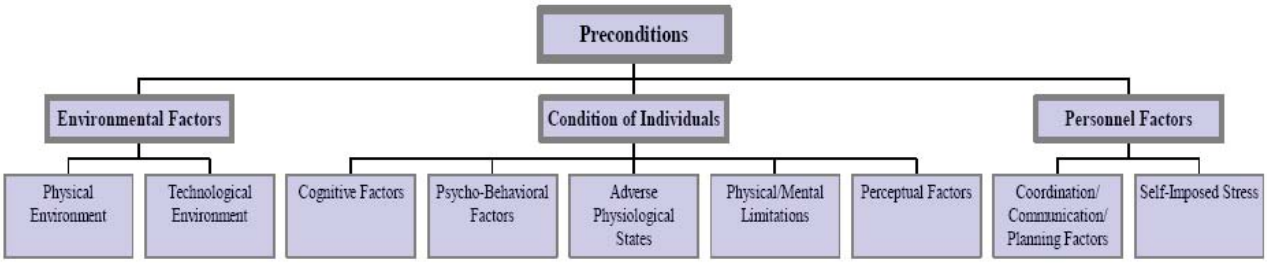


Figure 4. Categories of Preconditions for Unsafe Acts

2. Preconditions

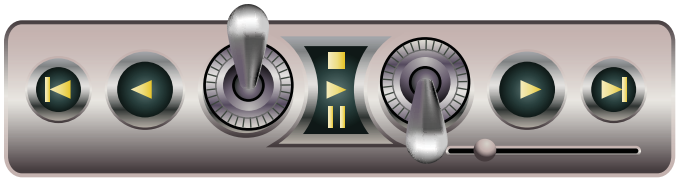
Preconditions are factors in a mishap if active and/or latent preconditions such as conditions of the operators, environmental or personnel factors affect practices, conditions or actions of individuals and result in human error or an unsafe situation (Figure 4). In this error analysis model preconditions include Environmental Factors, Condition of the Individuals and Personnel Factors.

Environmental Factors. Environmental factors are factors in a mishap if physical or technological factors affect practices, conditions and actions of individual and result in human error or an unsafe situation. Environmental factors include:

- **Physical Environment.** Physical environment are factors in a mishap if environmental phenomena such as weather, climate, white-out or dust-out conditions affect the actions of individuals and result in human error or an unsafe situation.
- **Technological Environment:** Technological environment are factors in a mishap when cockpit/vehicle/workspace design factors or automation affect the actions of individuals and result in human error or an unsafe situation.

Condition of the Individual. Condition of the individual are factors in a mishap if cognitive, psycho-behavioral, adverse physical state, or physical/mental limitations affect practices, conditions or actions of individuals and result in human error or an unsafe situation. Condition of the Individuals include:

- **Cognitive Factors:** Cognitive factors are factors in a mishap if cognitive or attention management conditions affect the perception or performance of individuals and result in human error or an unsafe situation.
- **Psycho-Behavioral Factors:** Psycho-Behavioral factors are factors when an individual's personality traits, psychosocial problems, psychological disorders or inappropriate motivation creates an unsafe situation.
- **Adverse Physiological States:** Adverse physiological states are factors when an individual experiences a physiologic event that compromises human performance and this decreases performance resulting in an unsafe situation.



- **Physical/Mental Limitations:** Physical/mental limitations are factors in a mishap when an individual lacks the physical or mental capabilities to cope with a situation, and this insufficiency causes an unsafe situation. This often, but not always, indicates an individual who does not possess the physical or mental capabilities expected in order to perform the required duties safely.
- **Perceptual Factors:** Perceptual factors are factors in a mishap when misperception of an object, threat or situation (visual, auditory, proprioceptive, or vestibular conditions) creates an unsafe situation. If investigators identify spatial disorientation (SD) in a mishap the preceding causal illusion should also be identified. Vice versa, if an illusion is identified as a factor in a mishap then the investigator should identify the resultant type of SD.

Personnel Factors: Personnel factors are factors in a mishap if self-imposed stressors or crew resource management affects practices, conditions or actions of individuals, and result in human error or an unsafe situation. Personnel factors include:

- **Coordination / Communication / Planning:** Coordination / communication / planning are factors in a mishap where interactions among individuals, crews, and teams involved with the preparation and execution of a mission that resulted in human error or an unsafe situation
- **Self-Imposed Stress:** Self-imposed stress are factors in a mishap if the operator demonstrates disregard for rules and instructions that govern the individuals readiness to perform, or exhibits poor judgment when it comes to readiness and results in human error or an unsafe situation. These are often violations of established rules that are in place to protect people from themselves and a subsequent unsafe condition. One example of self-imposed stress is drinking alcohol prior to operating a motor vehicle.

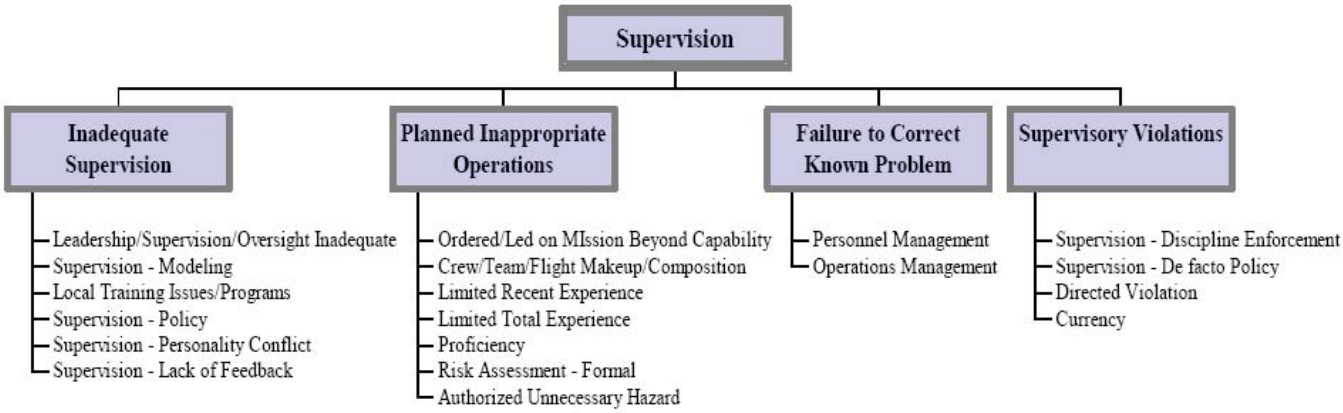
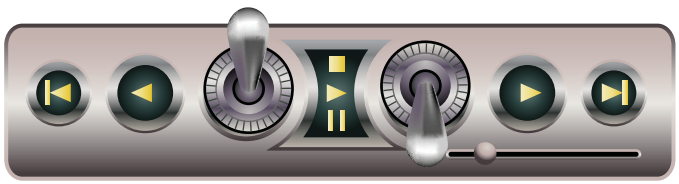


Figure 5. Categories of Unsafe Supervision

3. Supervision

The Human Factors Working Group has determined that a mishap event can often be traced back to the supervisory chain of command. As such, there are four major categories of Unsafe Supervision: Inadequate Supervision, Planned Inappropriate Operations, Failed to Correct a Known Problem, and Supervisory Violations (see Figure 5).

Inadequate Supervision: The role of supervisors is to provide their personnel with the opportunity to succeed. To do this, supervisors must provide guidance, training opportunities, leadership, motivation, and the proper role model, regardless of their supervisory level. Unfortunately, this is not always the case. It is easy to imagine a situation where adequate CRM training was not provided to an operator or team member. Conceivably, the operator's coordination skills would be compromised, and if put into a non-routine situation (e.g., emergency), would be at risk for errors that might lead to a mishap. Therefore, the category Inadequate Supervision accounts for those times when supervision



proves inappropriate, improper, or may not occur at all (see Table 6). Inadequate Supervision is a factor in a mishap when supervision proves inappropriate or improper and fails to identify a hazard, recognize and control risk, provide guidance, training and/or oversight and results in human error or an unsafe situation.

Planned Inappropriate Operations: Occasionally, the operational tempo or schedule is planned such that individuals are put at unacceptable risk, crew rest is jeopardized, and ultimately performance is adversely affected. Such Planned Inappropriate Operations, though arguably unavoidable during emergency situations, are not acceptable during normal operations. Included in this category are issues of crew pairing and improper manning. For example, it is not surprising to anyone that problems can arise when two individuals with marginal skills are paired together. During a period of downsizing and/or increased levels of operational commitment, it is often more difficult to manage crews. However, pairing weak or inexperienced operators together on the most difficult missions may not be prudent. Planned Inappropriate Operations is a factor in a mishap when supervision fails to adequately assess the hazards associated with an operation and allows for unnecessary risk. It is also a factor when supervision allows non-proficient or inexperienced personnel to attempt missions beyond their capability or when crew or flight makeup is inappropriate for the task or mission.

Failure to Correct a Known Problem: Failed to Correct a Known Problem refers to those instances when deficiencies among individuals, equipment, training or other related safety areas are "known" to the supervisor, yet are allowed to continue uncorrected. For example, the failure to consistently correct or discipline inappropriate behavior certainly fosters an unsafe atmosphere and poor command climate. Failure to Correct Known Problem is a factor in a mishap when supervision fails to correct known deficiencies in documents, processes or procedures, or fails to correct inappropriate or unsafe actions of individuals, and this lack of supervisory action creates an unsafe situation.

Supervisory Violations: Supervisory Violations, on the other hand, are reserved for those instances when supervisors willfully disregard existing rules and regulations. For instance, permitting an individual to operate an aircraft without current qualifications is a flagrant violation that invariably sets the stage for the tragic sequence of events that predictably follow. Supervisory Violations is a factor in a mishap when supervision, while managing organizational assets, willfully disregards instructions, guidance, rules, or operating instructions and this lack of supervisory responsibility creates an unsafe situation.

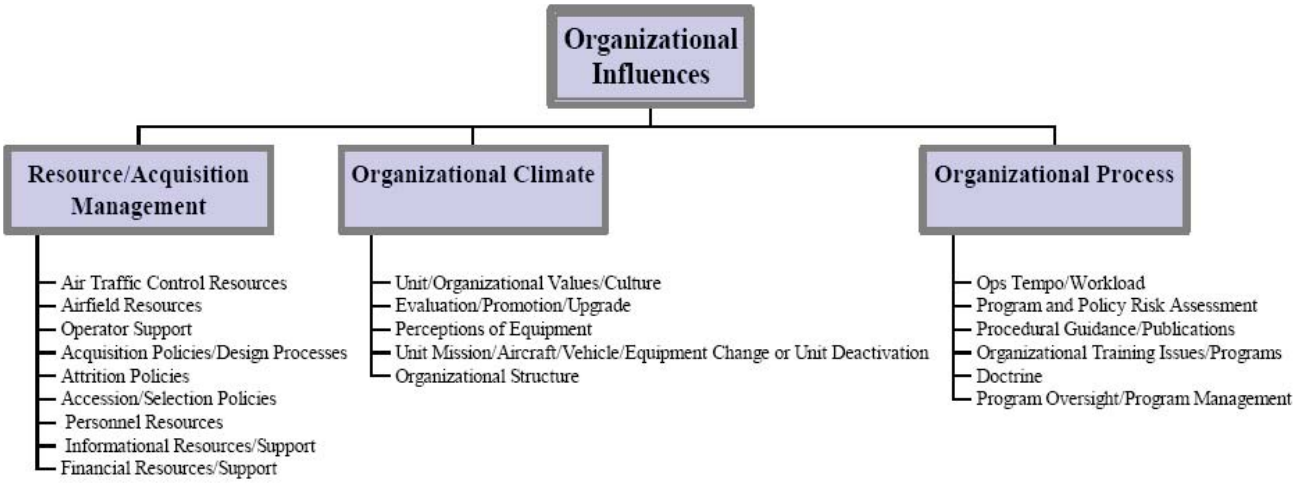
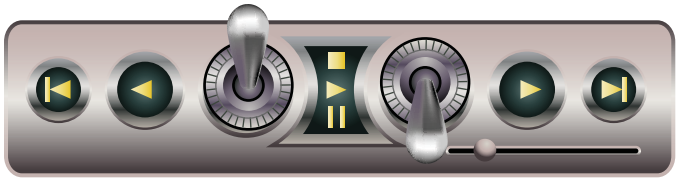


Figure 6. Categories of Organizational Influences



4. Organizational Influences

Fallible decisions of upper-level management directly effect supervisory practices, as well as the conditions and actions of operators. These latent conditions generally involve issues related to Resource/Acquisition Management, Organizational Climate, and Organizational Processes (see Figure 6). Organizational Influences are factors in a mishap if the communications, actions, omissions or policies of upper-level management directly or indirectly affect supervisory practices, conditions or actions of the operator's) and result in system failure, human error or an unsafe situation.

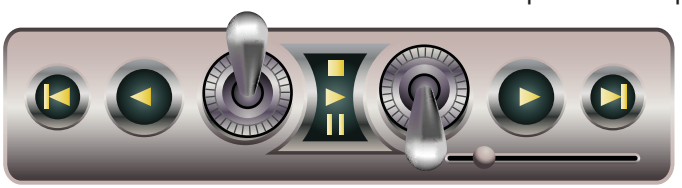
Resource / Acquisition Management: This category refers to the management, allocation, and maintenance of organizational resources--human, monetary, and equipment/facilities. The term "human" refers to the management of operators, staff, and maintenance personnel. Issues that directly influence safety include selection (including background checks), training, and staffing/manning. "Monetary" issues refer to the management of non-human resources, primarily monetary resources. For example, excessive cost cutting and lack of funding for proper equipment have adverse effects on operator performance and safety. Finally, "equipment/facilities" refers to issues related to equipment design, including the purchasing of unsuitable equipment, inadequate design of workspaces, and failures to correct known design flaws. Management should ensure that human-factors engineering principles are known and utilized and that existing specifications for equipment and workspace design are identified and met. Resource / Acquisition Management is a factor in a mishap if resource management and/or acquisition processes or policies, directly or indirectly, influence system safety and results in poor error management or creates an unsafe situation.

Organizational Climate: Organizational Climate refers to a broad class of organizational variables that influence worker performance. It can be defined as the situational consistencies in the organization's treatment of individuals. In general, Organizational Climate is the prevailing atmosphere or environment within the organization. Within the present classification system, climate is broken down into three categories--structure, policies, and culture. The term "structure" refers to the formal component of the organization. The "form and shape" of an organization are reflected in the chain-of-command, delegation of authority and responsibility, communication channels, and formal accountability for actions. Organizations with maladaptive structures (i.e., those that do not optimally match to their operational environment or are unwilling to change) will be more prone to mishaps. "Policies" refer to a course or method of action that guides present and future decisions. Policies may refer to hiring and firing, promotion, retention, raises, sick leave, drugs and alcohol, overtime, accident investigations, use of safety equipment, etc. When these policies are ill-defined, adversarial, or conflicting, safety may be reduced. Finally, "culture" refers to the unspoken or unofficial rules, values, attitudes, beliefs, and customs of an organization ("The way things really get done around here."). Other issues related to culture include organizational justice, psychological contracts, organizational citizenship behavior, esprit de corps, and union/management relations. All these issues affect attitudes about safety and the value of a safe working environment. Organizational Climate is a factor in a mishap if organizational variables including environment, structure, policies, and culture influence individual actions and results in human error or an unsafe situation.

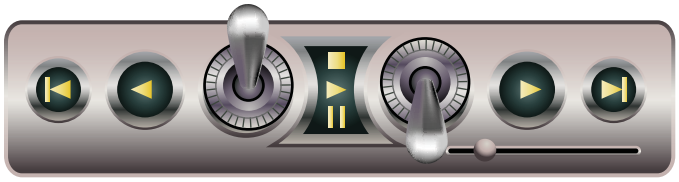
For More information on the DoD HFACS download the DoD Human Factors Guide!

You will find all of the nano-codes which will help you identify specific factors in each category for your investigations.

Organizational Processes: This category refers to the formal process by which "things get done" in the organization. It is subdivided into three broad categories--operations, procedures, and oversight. The term "operations" refers to the characteristics or conditions of work that have been established by management. These characteristics include operational tempo, time pressures, production quotas, incentive systems, and schedules. When set up inappropriately, these working conditions can be detrimental to safety. "Procedures" are the official or formal procedures as to how the job is to be done. Examples include performance standards,



objectives, documentation, and instructions about procedures. All of these, if inadequate, can negatively impact employee supervision, performance, and safety. Finally, “oversight” refers to monitoring and checking of resources, climate, and processes to ensure a safe and productive work environment. Issues here relate to organizational self-study, risk management, and the establishment and use of safety programs. Organizational Processes is a factor in a mishap if organizational processes such as operations, procedures, operational risk management and oversight negatively influence individual, supervisory, and/or organizational performance and results in unrecognized hazards and/or uncontrolled risk and leads to human error or an unsafe situation.



US Army School of Aviation Medicine
301 Dustoff
Fort Rucker , AL 36362

334 • 255 • 7460
http://usasam.amedd.army.mil